

WHAT IS CLAIMED IS:

1. An electrochemical cell comprising:

a first electrode;

a second electrode; and

an electrolyte in ionic communication with the first electrode and the second electrode,

5 wherein the electrolyte comprises a polymer matrix material comprising a polymerization product of one or more monomers selected from the group of water-soluble, ethylenically-unsaturated acids and acid derivatives and a crosslinking agent, wherein a quantity of water is used for polymerization, the quantity being selected to swell the polymer material to a defined volume upon curing, and wherein the water in the polymer matrix material is replaced with a
10 solution of a desired species.

2. The electrochemical cell as in claim 1, wherein the polymer matrix material further comprises a water-soluble or water-swellaable polymer.

3. The electrochemical cell as in claim 1, wherein the polymer matrix material further comprises a chemical polymerization initiator.

4. The electrochemical cell as in claim 1, wherein the polymer matrix material further comprises:

a water-soluble or water-swellaable polymer; and

a chemical polymerization initiator.

5. The electrochemical cell as in claim 1, wherein the polymer matrix material further comprises a neutralizing agent.

6. The electrochemical cell as in claim 1, wherein the volume of the polymer matrix material after species replacement deviates from the volume of the polymer matrix material before species replacement by less than about 50%.

7. The electrochemical cell as in claim 1, wherein the volume of the polymer matrix material after species replacement deviates from the volume of the polymer matrix material before species replacement by less than about 20%.

8. The electrochemical cell as in claim 1, wherein the volume of the polymer matrix material after species replacement deviates from the volume of the polymer matrix material before species replacement by less than about 5%.

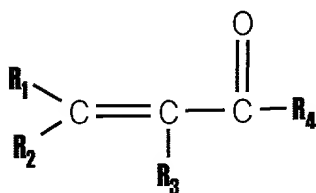
9. The electrochemical cell as in claim 1, wherein the species for replacing water in the polymer matrix material is selected from the group consisting of anion conducting species, cation conducting species, neutral species, electrochromic species, and combinations comprising at least one of the foregoing species.

10. The electrochemical cell as in claim 1, wherein water comprises about 50% to about 90%, on a weight basis, of the polymer matrix material prior to species replacement.

11. The electrochemical cell as in claim 1, wherein water comprises about 60% to about 80%, on a weight basis, of the polymer matrix material prior to species replacement.

12. The electrochemical cell as in claim 1, wherein water comprises about 62% to about 75%, on a weight basis, of the polymer matrix material prior to species replacement.

13. The electrochemical cell as in claim 1, wherein the water soluble ethylenically unsaturated acids and acid derivatives have the general formula:



wherein R1, R2, and R3 are independently selected from the group consisting of H, C, C2-C6

5 alkanes, C2-C6 alkenes, C2-C6 alkynes, aromatics, halogens, carboxylic acid derivatives, sulfates and nitrates; and

R4 is selected from the group consisting of NR5, NHR5, NH2, OH, H, halides, OR5, and

carboxylic acid derivatives, wherein R5 is selected from the group consisting of H, C, C2-C6 alkanes, C2-C6 alkenes, C2-C6 alkynes, and aromatics.

14. The electrochemical cell as in claim 1, wherein the water soluble ethylenically unsaturated acids and acid derivatives are selected from the group consisting of methylenebisacrylamide, acrylamide, methacrylic acid, acrylic acid, fumaramide, fumaric acid, N-isopropylacrylamide, N, N-dimethylacrylamide, 3,3-dimethylacrylic acid, maleic anhydride, and combinations comprising at least one of the foregoing ethylenically

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unsaturated acids and derivatives.

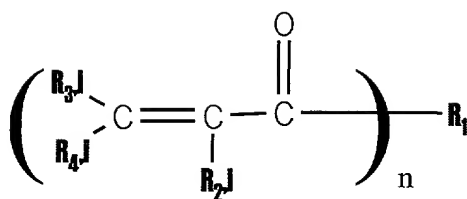
15. The electrochemical cell as in claim 1, wherein the water soluble ethylenically unsaturated acids and acid derivatives are selected from the group consisting of 1-vinyl-2-pyrrolidinone, the sodium salt of vinylsulfonic acid, and combinations comprising at least one of the foregoing ethylenically unsaturated acids and derivatives.

16. The electrochemical cell as in claim 1, wherein the ethylenically unsaturated acids or acid derivatives comprises about 5% to about 50%, by weight, of the total monomer solution prior to polymerization.

17. The electrochemical cell as in claim 1, wherein the ethylenically unsaturated acids or acid derivatives comprises about 7% to about 25%, by weight, of the total monomer solution prior to polymerization.

18. The electrochemical cell as in claim 1, wherein the ethylenically unsaturated acids or acid derivatives comprises about 10% to about 20%, by weight, of the total monomer solution prior to polymerization.

19. The electrochemical cell as in claim 1, wherein the crosslinking agent is of the general formula:



5 wherein $i=1 \dots n$, and $n \geq 2$;

$R_{2,i}$, $R_{3,i}$, and $R_{4,i}$ are independently selected from the group consisting of H, C, C2-C6 alkanes, C2-C6 alkenes, C2-C6 alkynes, aromatics, halogens, carboxylic acid derivatives, sulfates and nitrates;

R_1 is selected from the group consisting of N, NR_5 , NH, O, and carboxylic-acid derivatives,

10 wherein R_5 is selected from the group consisting of H, C, C2-C6 alkanes, C2-C6 alkenes, C2-C6 alkynes, and aromatics.

20. The electrochemical cell as in claim 1, wherein the crosslinking agent is selected from the group consisting of methylenebisacrylamide, ethylenebisacrylamide, any water-soluble N,N'-alkylidene-*bis*(ethylenically unsaturated amide), 1,3,5-Triacryloylhexahydro-1,3,5-triazine, and combinations comprising at least one of the foregoing crosslinking agents.

21. The electrochemical cell as in claim 1, wherein the crosslinking agent comprises about 0.01% to about 15%, by weight, of the total monomer solution prior to polymerization.

22. The electrochemical cell as in claim 1, wherein the crosslinking agent comprises about 0.5% to about 5%, by weight, of the total monomer solution prior to polymerization.

23. The electrochemical cell as in claim 1, wherein the crosslinking agent comprises about

1% to about 3%, by weight, of the total monomer solution prior to polymerization.

24. The electrochemical cell as in claim 1, wherein the desired species comprises an alkaline solution.

25. The electrochemical cell as in claim 24, wherein the alkaline solution comprises KOH.

26. The electrochemical cell as in claim 25, wherein the conductivity is greater than about 0.1 Siemens per centimeter.

27. The electrochemical cell as in claim 25, wherein the conductivity is greater than about 0.2 Siemens per centimeter.

28. The electrochemical cell as in claim 25, wherein the conductivity is greater than about 0.4 Siemens per centimeter.

29. The electrochemical cell as in claim 2, wherein the water-soluble or water-swella-
polymer is selected from the group consisting of polysulfone (anionic), poly(sodium-4-
styrenesulfonate), carboxymethyl cellulose, polysulfone (anionic), sodium salt of
poly(styrenesulfonic acid-co-maleic acid), corn starch, any other water-soluble or water-
5 swella-
ble polymers, and combinations comprising at least one of the foregoing polymers.

30. The electrochemical cell as in claim 2, wherein the water-soluble or water-swella-

polymer comprises less than about 30%, by weight, of the polymer matrix material.

31. The electrochemical cell as in claim 2, wherein the water-soluble or water-swella-
polymer comprises about 1% to about 10%, by weight, of the polymer matrix material.

32. The electrochemical cell as in claim 2, wherein the water-soluble or water-swella-
polymer comprises about 1% to about 4%, by weight, of the polymer matrix material.

33. The electrochemical cell as in claim 4, wherein the water-soluble or water-swella-
polymer is selected from the group consisting of polysulfone (anionic), poly(sodium-4-
styrenesulfonate), carboxymethyl cellulose, polysulfone (anionic), sodium salt of
poly(styrenesulfonic acid-co-maleic acid), corn starch, any other water-soluble or water-
5 swellable polymers, and combinations comprising at least one of the foregoing polymers.

34. The electrochemical cell as in claim 4, wherein the water-soluble or water-swella-
polymer comprises less than about 30%, by weight, of the polymer matrix material.

35. The electrochemical cell as in claim 4, wherein the water-soluble or water-swella-
polymer comprises about 1% to about 10%, by weight, of the polymer matrix material.

36. The electrochemical cell as in claim 4, wherein the water-soluble or water-swella-
polymer comprises about 1% to about 4%, by weight, of the polymer matrix material.

37. The electrochemical cell as in claim 3, wherein the chemical polymerization initiator is selected from the group consisting of ammonium persulfate, alkali metal persulfates and peroxides, and combinations comprising at least one of the foregoing initiators.

38. The electrochemical cell as in claim 3, wherein the chemical polymerization initiator comprises less than about 3%, by weight, of the polymer matrix material.

39. The electrochemical cell as in claim 4, wherein the chemical polymerization initiator is selected from the group consisting of ammonium persulfate, alkali metal persulfates and peroxides, and combinations comprising at least one of the foregoing initiators.

40. The electrochemical cell as in claim 4, wherein the chemical polymerization initiator comprises less than about 3%, by weight, of the polymer matrix material.

41. The electrochemical cell as in claim 1, wherein the first electrode is a metal fuel and the second electrode is an air diffusion electrode.

42. The electrochemical cell as in claim 1, wherein the first electrode comprises a hydrogen evolving electrode and the second electrode comprises an air diffusion electrode.

43. The electrochemical cell as in claim 1, wherein the first electrode is a metal fuel and the second electrode is an air diffusion electrode, and further comprising a third electrode in electrical communication with the first electrode and in electrical isolation from the second

electrode.